



712CD

75TH MORSS CD Cover Page

If you would like your presentation included in the 75th MORSS Final Report CD it must :

1. Be unclassified, approved for public release, distribution unlimited, and is exempt from U.S. export licensing and other export approvals including the International Traffic in Arms Regulations (22CFR120 et seq.);
2. Include MORSS Form 712CD as the first page of the presentation;
3. Have an approved MORSS form 712 A/B and
4. Be turned into the MORSS office no later than: **DEADLINE: 14 June 2007 (Late submissions will not be included.)**

Author Request (To be completed by applicant) - The following author(s) request authority to disclose the following presentation in the MORSS Final Report, for inclusion on the MORSS CD and/or posting on the MORSS web site.

Name of Principal Author and all other author(s) Mr. Cortes (Steve) D Stephens, USMC
 Dr. Robert Sheldon
 LT Robin Marling, USA

Principal Author's Organization and address:

MCDC Studies and Analysis Division
 Quantico, VA 22134

Phone: 703-784-6029

Fax: 703-784-9547

Email: cortes.stephens@usmc.mil

Please use the same title listed on the 75th MORSS Disclosure Form 712 A/B. If the title of the presentation has changed please list both.)

Original title on 712 A/B: Analyzing Irregular Warfare (IW) using a Narrative Approach and Agent-based Modeling

If the title was revised please list the original title above and the revised title here:
 Analyzing Irregular Warfare (IW) with Agent-based Modeling

PRESENTED IN:

WORKING GROUP: 10

DEMONSTRATION

COMPOSITE GROUP:

POSTER:

SPECIAL SESSION 1:

TUTORIAL:

SPECIAL SESSION 2:

OTHER:

SPECIAL SESSION 3:

This presentation is believed to be: *Unclassified, approved for public release, distribution unlimited, and is exempt from U.S. export licensing and other export approvals including the International Traffic in Arms Regulations (22CFR120 et seq.)*

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 JUN 2007		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Analyzing Irregular Warfare (IW) with Agent-Based Modeling				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Corps Combat Development Command (MCCDC) Quantico, VA 22184				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM202526. Military Operations Research Society Symposium (75th) Held in Annapolis, Maryland on June 12-14, 2007, The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 18	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Si ne petes veritatem, Non querere nos

Analyzing Irregular Warfare (IW) with Agent-Based Modeling

LT Robin Marling, USN

Dr. Bob Sheldon

Mr. Cortez (Steve) Stephens

Operations Analysis Division (OAD)

Marine Corps Combat Development Command (MCCDC)

75th MORSS

WG-16



Purpose

- **Set forth results to date of the U.S. Marine Corps Irregular Warfare (IW) study**
- **IW study problem**
 - **Given**
 - **Joint, Combined, Inter-Agency, Counterinsurgency (COIN) Environment**
 - **Marine Air-Ground Task Force (MAGTF) Area of Operations COIN mission**
 - **Provide**
 - **Plausible range of resultant civilian population behaviors**



Agenda

- **IW Study Quad Chart**
- **IW Modeling Challenge**
- **Insurgency Behavior Model**
- **Pythagoras Counterinsurgency Application**
- **Critical Issues for Analyzing IW**



Irregular Warfare (IW) Study

• Background

The Joint community has called for analyses in IW, yet very little has been done in the detailed development of irregular scenarios, and even less in the analysis of them.

• Study Question

What is a **good methodology** for analyzing Marine Corps **IW** problems **in-house**?

• Findings

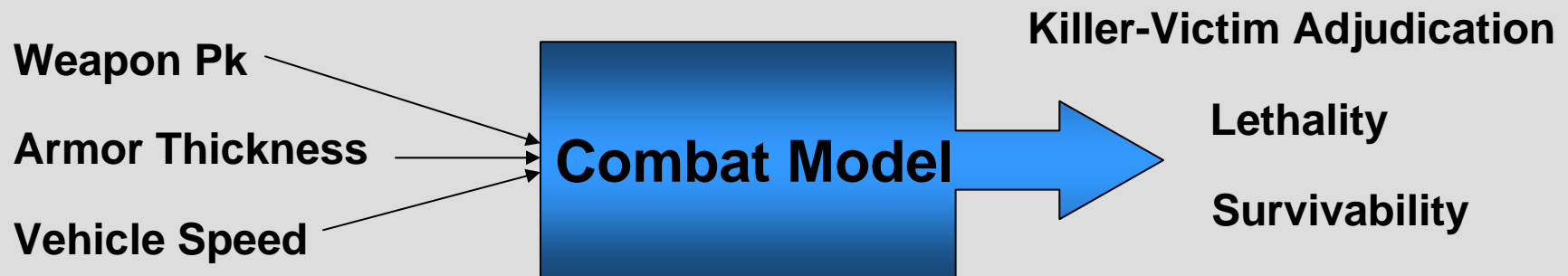
- Rich counterinsurgency literature
- Interagency aspect is a challenge
- **Civilian population is key**
- Population security is critical
- Irregular wars last years, not months
- Two promising methodologies
 - Population Dynamics
 - **Agent-Based Models**



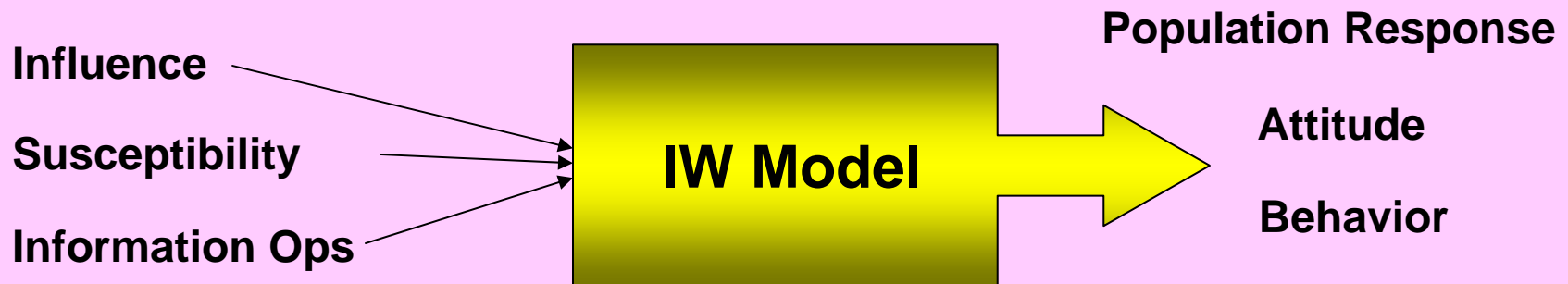


The IW Modeling Challenge

Military OR Analyst Comfort Zone



IW Domain



The Challenge: Different data, different algorithms, different MOEs



IW Modeling: Expectation Management

“Soft Sciences” typically have much lower statistical correlation than “Hard Sciences”

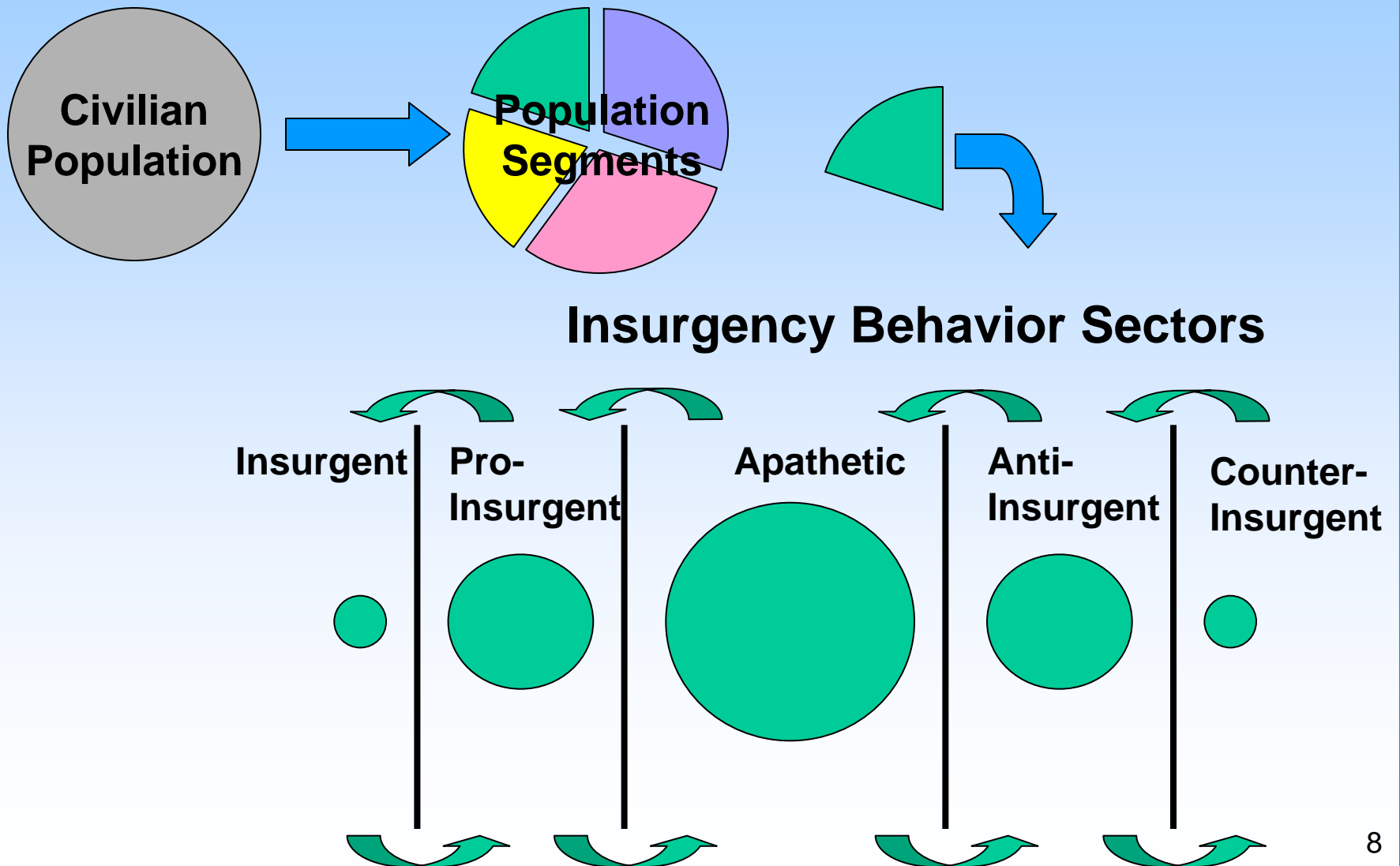
- As a practical matter, for typical data found in the social sciences, values of r^2 as low as .25 are often considered useful. For data in the physical and medical sciences, r^2 values of .60 or greater are often found; in fact, in some cases, r^2 values greater than .90 can be found.***

Modeling human behavior involves a higher level of uncertainty than modeling traditional force-on-force combat

*** *Statistics for Business and Economics* by Anderson, Sweeney, and Williams⁷**



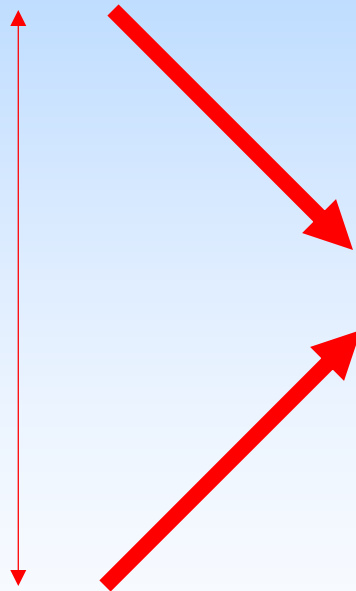
Civilian Population



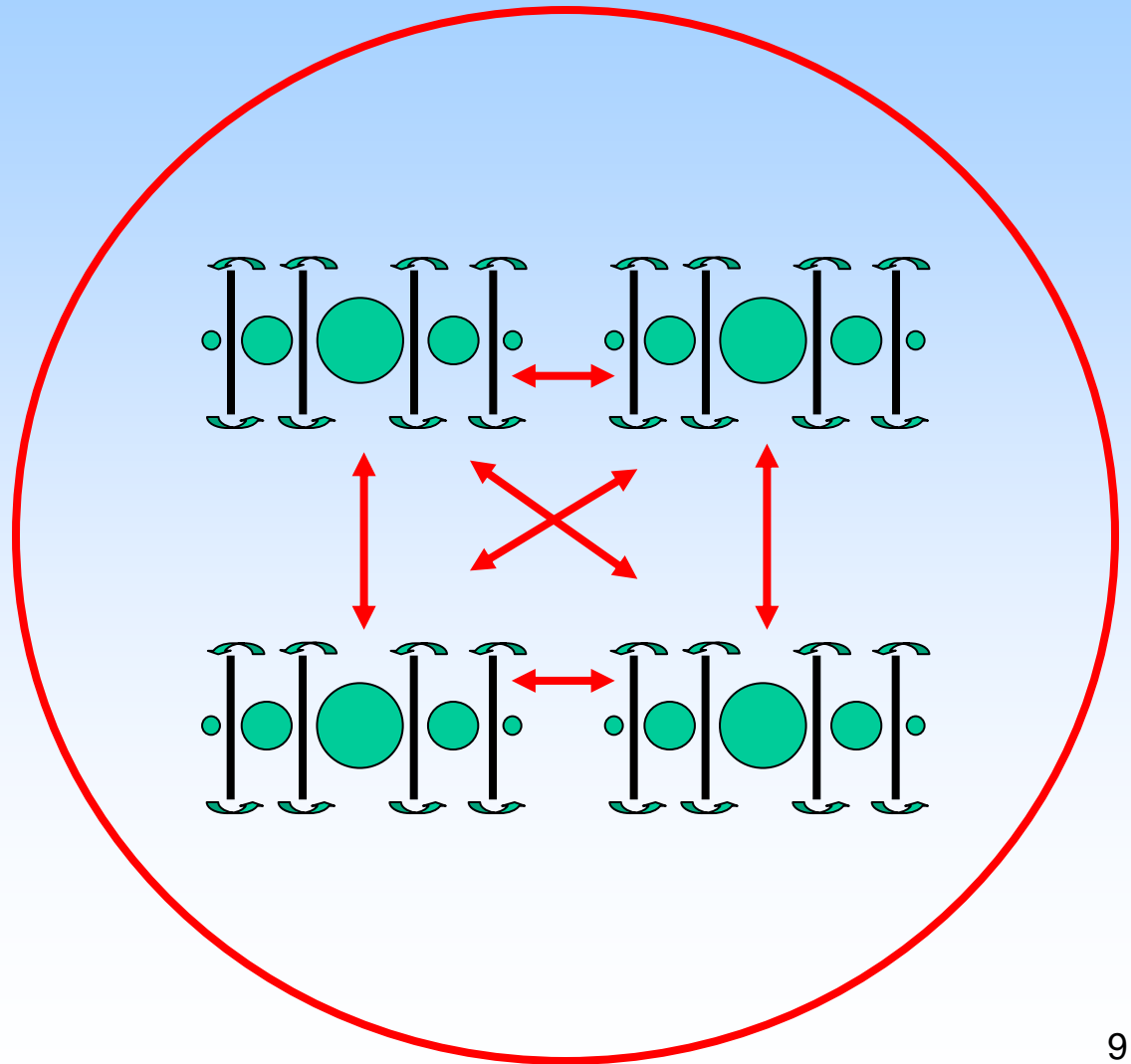


Insurgency Behavior Model

Insurgents



Counterinsurgents





Pythagoras Counterinsurgency Application

Akela Province

Fictitious “Troubled Country”
Developmental Scenario

Troubled Country’s government is stressed and has turned to the United Nations for assistance combating the insurgency. A combined task force consisting of U.S. and British ground forces (including a MAGTF) has entered the country.

Colombia

Fictitious Scenario: “Operation Pacific Breeze” - - Humanitarian assistance / disaster relief
Deploy a Marine Expeditionary Unit (MEU) and a Marine Expeditionary Brigade (MEB)





Pythagoras Input

- **Population segments & sectors**
- **Population segment demographics**
- **Scenario event list**
- **Population segment behaviors, interrelations, vulnerabilities, & influences**



Pythagoras Input, cont.

- **Data required**
 - Prevalence of current behavior patterns
 - Susceptibility from unfulfilled perceived needs
 - Influence effect of events
 - Interactive influence effect of others
 - Attractiveness of others
- **Probabilities, percentages, and ordinal numbers (quantitative, but non-empirical)**
- **Data sources**
 - Culture-ware SMEs

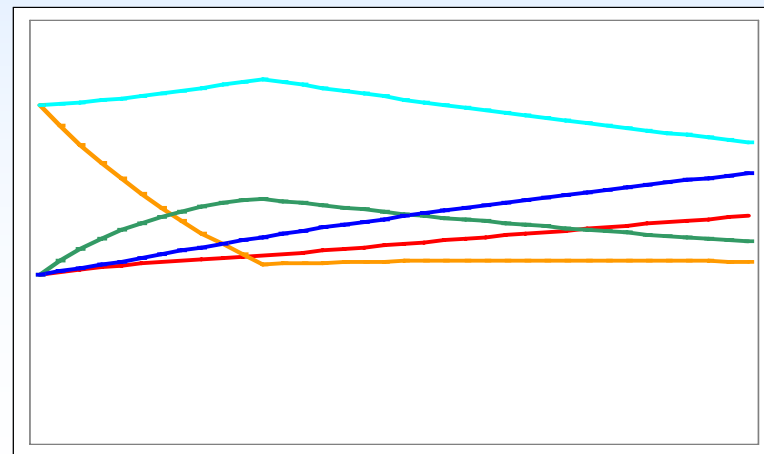
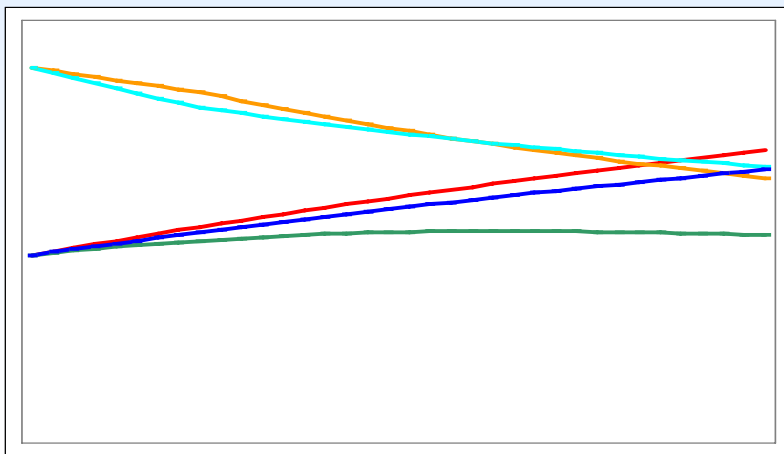
“It’s the data, Stupid!” Dr. Akst



Output

- **Change in population segment behaviors over time**
 - **Experimental design**
 - **Independent variable: MAGTF COA**
 - **COA example: Minimize footprint ashore vs. Establish base camp**

Notional Output





Critical Issues for Analyzing IW

- **Credibility**
- **Analytical rigor**
- **Time**
- **Distance**
- **Resolution**
- **Scalability**
- **Population shifts**



Questions?

- **LT Robin Marling, USN**
 - **Robin.Marling@usmc.mil**
- **Dr. Bob Sheldon**
 - **Robert.Sheldon.ctr@usmc.mil**
- **Mr. Steve Stephens**
 - **Cortez.Stephens@usmc.mil**



Backup Slides

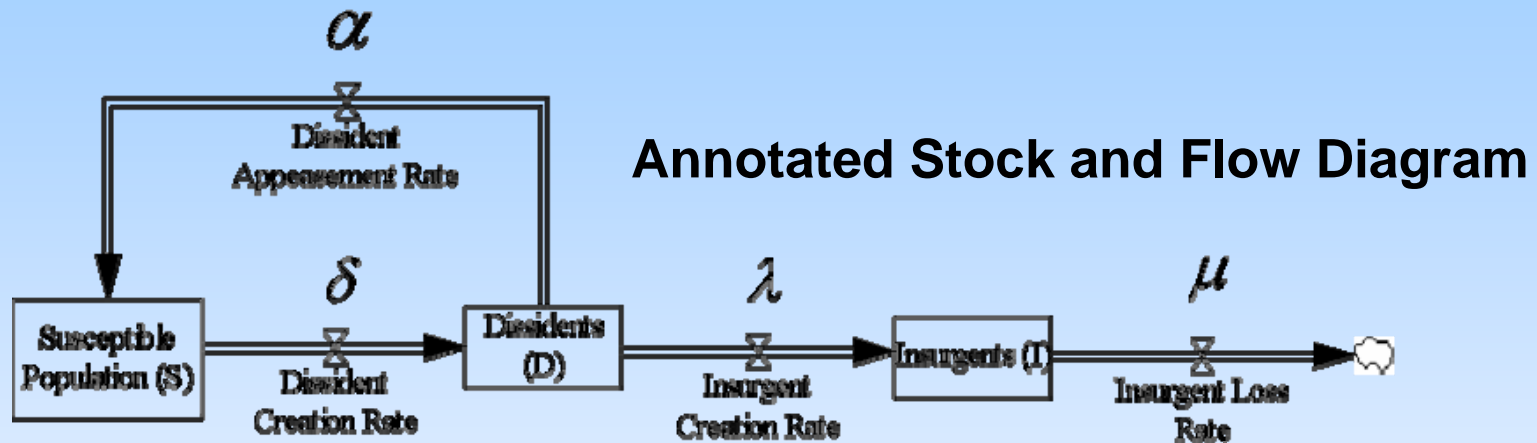


Agent-Based Simulation VV&A

- **1-2 May 2007 ABS VV&A Workshop Goal: Develop general, institutionally acceptable processes and criteria for assessing the validity of agent-based simulations used as part of DoD analyses**
- **Workshop summary**
 - **Elements of validation: results, referent, bounding principle**
 - **ABS validation**
 - **Validation techniques: data validation, SME validation**
 - **Data validation**
 - **Requirements for declaring an ABS valid for an application**



Insurgency System Dynamics Model



Mathematical Model

$$\frac{dP}{dt} = \frac{dS}{dt} + \frac{dD}{dt} + \frac{dI}{dt}$$

$$\frac{dS}{dt} = \alpha - \delta$$

$$\frac{dD}{dt} = \delta - \lambda - \alpha$$

$$\frac{dI}{dt} = \lambda - \mu$$